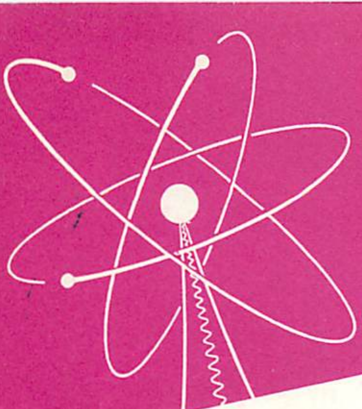

COLOR IN MONOCHROME PICTURES

Lesson T4E-14B

DeVRY Technical Institute
4141 W. Belmont Ave., Chicago 41, Illinois
Formerly DeFOREST'S TRAINING, INC.

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T4E-14B

COLOR IN MONOCHROME PICTURE

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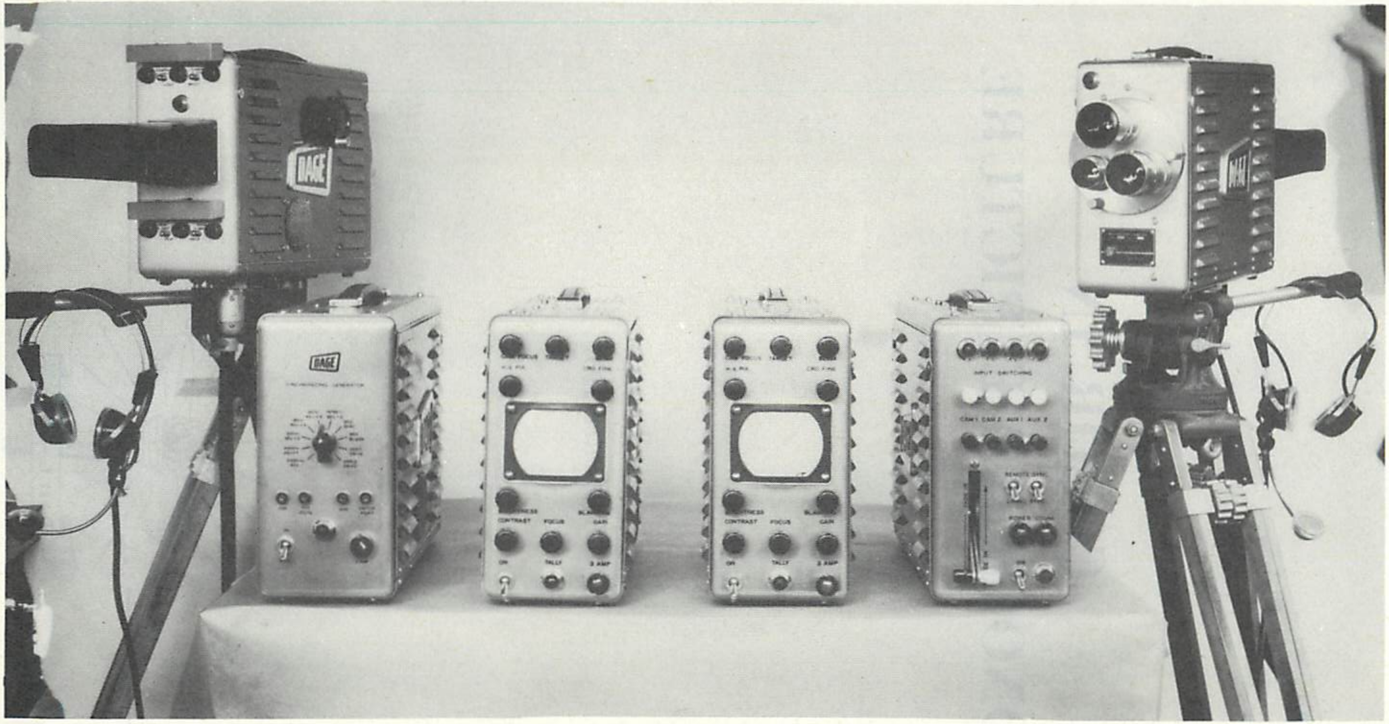


The equipment pictured here will be found in many studios as well as being commonly used for remote pickups. The central units for each camera are in the center while the sync generator and switching unit are on the left and right side respectively.

Dage Television Division—Thompson Products, Inc.

COLOR IN MONOCHROME PICTURE

Contents

PAGE

Overall Raster Tinting 4

Overall Picture Tinting 9

Horizontal Color Bars 12

No Monochrome Picture 13

Improper Color Purity 17

  Edge Contamination 17

  Center Contamination 18

Color Fringing 20

  Electrostatic Convergence Tubes 20

  Magnetic Convergence Tubes 23

The story of the phototube is that of a modern miracle. Its accomplishments have been so numerous, so amazing, that they seem almost exaggerated. Yet what has been accomplished thus far is but a start; the future holds promise of developments and uses even more remarkable. We are on the threshold of the Electronic Age, the development of which will produce devices and accomplish results beyond our imagination. Phototubes will play an increasingly important part in that development.

—Selected

COLOR IN MONOCHROME PICTURE

The troubleshooting procedures for a color television receiver are basically the same as those employed for black-and-white TV receivers. However, because of the additional circuits in a color TV receiver, much valuable time is wasted if the technician is not capable of analyzing the symptoms properly.

As in a black-and-white receiver, a careful examination of the image—or a lack of one—goes a long way towards isolating the trouble to the proper stage. In order for a comprehensive analysis to be made, the technician must be familiar with the fundamentals of colorimetry, have a good understanding of the manner in which the circuits function, and be familiar with the particular receiver under test. Also, the technician must be capable of using the color-bar generator and evaluating the waveforms that are observed on the scope.

In order to apply the test procedures explained in this lesson it is assumed that the technician has available the necessary test equipment such as a color-bar generator, a white-dot generator, an oscilloscope capable of measuring the 3.58 mc color signals and the usual collection of test equipment that is found in most TV service shops.

Most troubles can be divided into two categories: (1) troubles affecting only the proper reproduction of a color picture and (2) troubles affecting the operation of the monochrome picture as well as the color picture.

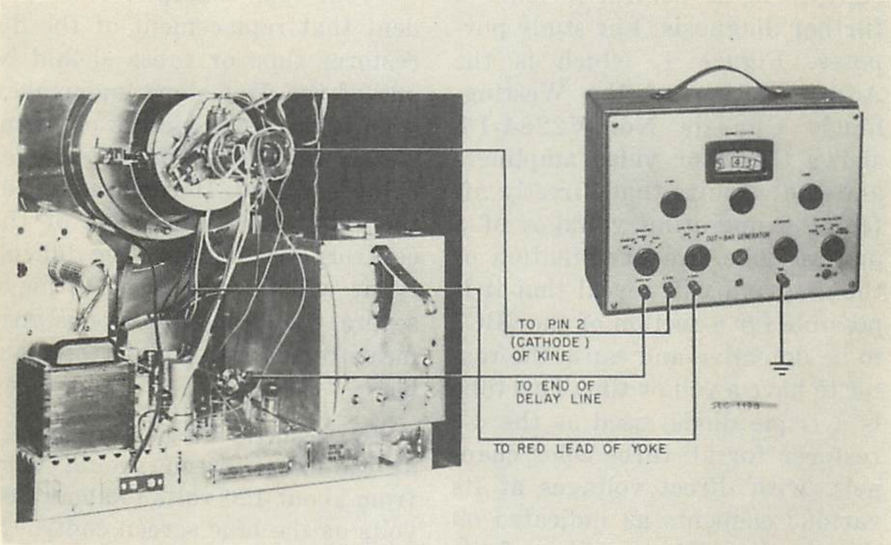
OVERALL RASTER TINTING

Probably the first thing to do when troubleshooting a color TV receiver is to tune in a black-and-white telecast and check the operation of the receiver for a monochrome picture. If the monochrome picture is satisfactory but the color picture is not, the difficulty must be one that affects only the color circuits in the receiver. Since we want to confine most of our explanations to troubles which allow color in a monochrome picture, faults which affect only color reproduction will be explained in the next lesson.

If the monochrome picture is not satisfactory, the circuits through which the luminance signal must pass, the circuits that directly affect the picture tube and the power supply circuits must be investigated.

One of the most common faults that will be encountered is an overall tinting of a monochrome picture. For example, assume that the monochrome picture has an overall yellow color instead of being black-and-white. Under these conditions, video signal is removed by turning the contrast control down or removing one of the video i-f amplifier tubes. If the raster that is observed is still a shade of yellow, then it can be assumed that the circuits which directly affect the picture tube are at fault. This line of thinking is based upon the fact that all of the direct voltages applied to the various elements of the picture tube must be correct before a "black-and-white" raster can be obtained.

From the study of colorimetry, we know that yellow is a mixture of red and green light. We also know white light contains all three of the primary colors—red, green, and blue. Therefore, it can be assumed reasonably that the yellow raster is a deficiency of blue light or an excessive amount of red and green light with the probabilities in favor of the former assumption.



When making the convergence adjustments or checking the operation of the convergence circuits, one method of connecting the dot-bar generator to the RCA Model CT-155 Color TV receiver is shown above.

Courtesy RCA Service Company, Inc.

A lack of light output from the blue phosphor could be caused by a reduction in the blue screen voltage, an increase of bias between grid and cathode of the blue gun or a defect in the blue gun itself. Regardless of the type of receiver being serviced, the blue screen control and the blue background control should be adjusted to see if the difficulty can be corrected.

If adjustment of the blue screen and blue background controls does not correct the trouble, a knowledge of the receiver circuitry will be helpful to make a further diagnosis. For study purposes, Figure 1, which is the Adder section of the Westinghouse Chassis No. V2284-15, shows the color video amplifiers and the circuits that directly affect the operating voltages of a picture tube. An examination of the diagram will reveal that it is possible for a section of the 6BC7 to be defective and cause the raster to have a yellow tint. This tube is a triple diode, used as the d-c restorer for all three color channels, with direct voltages at its various elements as indicated on the diagram. That portion of the tube used as the "blue clamp" or blue d-c restorer should have 0-90 volts at its cathode depending upon the setting of the master brightness control and the blue background control.

This voltage is then applied through R_{437}, and the combination of L_{401} and R_{436}, to the grid of the blue gun (pin #18). If the blue clamp section of the tube were shorted internally from pin 7 to the filament (pin #4 grounded), this would place the cathode of the blue d-c restorer and the grid of the blue gun at ground potential. Since the cathode of the blue gun is about 120 volts positive, the blue gun is cut off resulting in a yellow raster. Replacement of the defective 6BC7 will cure the difficulty in this case.

From this example, it is evident that replacement of the d-c restorer tube or tubes should be one of the first steps undertaken even if the technician is not completely familiar with the receiver being serviced. If replacement of the tube and adjustment of the controls does not cure the difficulty, it will be necessary to make several voltage and resistance measurements to isolate the trouble.

For a static check, the voltage at the blue screen should vary from about 120 volts to about 300 volts as the blue screen control is turned from its fully counterclockwise position to its fully clockwise position. If this voltage remains at about 120 volts regardless of the setting of the blue screen control, the probable fault here is an open screen control at the point where it connects to R_{440} and R_{461}. Another component that could cause the blue screen voltage to be low, or zero, is C_{407}. If the capacitor is leaky the blue screen voltage will reduce proportional to the amount of leakage, dropping to zero when the capacitor is completely shorted.

It is also possible for the blue gun to stop conducting due to an open in the blue grid or cathode circuits. An open in resistor R_{437} would break the blue grid return circuit, whereas a defect in switch SW_{401} could open the blue cathode circuit. These switches in the cathode circuits are for the purpose of simplifying the set-up procedure. Instead of reducing the screen voltage to cut off one of the guns, the switch is placed in the up position on the diagram and a positive 410 volts is applied to the cathode which biases the gun to cutoff.

Not to be overlooked is the possibility that the picture tube is defective and causes the trouble described. Therefore, it is a good policy to measure the element voltages directly at the socket of the picture tube with the socket on and off the base of the tube. If the voltages are normal with the socket removed from the base of the CRT, the chances are that the picture tube is defective.

Another point of considerable interest is that the fault could be due to a portion of the picture tube filament being open. Even though there are only two filament pin connections on the tube base, each gun has its own filament. The connections from these three filaments tie to a common filament line which, in turn, connects to the #1 and #20 filament pins. Accordingly, it is very likely that only one of the three filaments would open. This can be determined by very carefully examining the neck of the picture tube, while the receiver is in operation, to see if all three filaments glow.

Troubles in the circuits mentioned above could also show up as an overall blue raster instead of an overall yellow raster. This condition could be caused either by increased conduction of the blue gun or decreased conduction of the red and green guns with the probabilities in favor of the former condition.

Assuming that the screen and cathode voltages have been checked and found normal, the blue raster condition could be caused by a defect in C_{412} or C_{413}. If either one of these capacitors becomes leaky or shorted, an increase in positive voltage occurs on the blue grid.

Finally, it is possible for the blue screen control to be defective and cause an increased conduction of the blue gun. If the screen voltage reads high (about 300 volts), in this receiver, and does not change as the blue screen control is adjusted, the open would be at the low voltage end of the control. With one end of the control connected to the positive 300 volt point and the other end disconnected, the movable arm of the control is at the same 300 volts positive regardless of its setting.

Similar conditions can occur in regard to the action of the green gun and the red gun. If the raster has an overall red tint or an overall cyan tint, the circuits affecting the conduction of the red gun should be checked. If the raster has an overall green tint or an overall magenta tint, the circuits affecting the green gun should be checked.

A portable tube tester, such as the one pictured here, can be of considerable assistance to the technician in locating defective tubes.
Courtesy Sylvania Electric Products, Inc.

It should be remembered that the voltages on the three screen grids, on the three control grids and on the three cathodes are not necessarily the same. Due to the difference in efficiencies of the phosphors, the red screen will usually have the highest voltage, the green screen the next highest voltage and the blue screen the lowest voltage. For the exact direct voltages at the various elements, always refer to the manufacturer's specifications.

In the circuit of Figure 1, capacitive coupling is employed between the color amplifier outputs and the grids of the picture tube with d-c restorers being used in each grid circuit. In the circuit of Figure 2, the chrominance signal is direct coupled from the color-difference amplifiers to the grids of the picture tube while the luminance signal is applied to the cathodes of the picture tube. Therefore, any changes in the d-c plate voltages of the color-difference amplifiers will cause corresponding changes in the grid voltages of the picture tube.

For example, if exactly the same symptoms are displayed by this receiver, that is, the raster has an overall blue or yellow tint, the trouble could be caused by components other than those mentioned when analyzing the circuit of Figure 1. If the raster has an overall blue tint, the fault could be due to failure of B-Y amplifier V_{30A} to conduct. With no voltage drop across R_{182}, the full B+ of 240 volts would be applied to the blue grid. Exactly the same conditions would exist if coil L_{53} were to open.

If the raster were to take on an overall yellow tint, due to a decrease in the voltage on the blue grid, the trouble could be isolated to a cathode-to-filament short in V_{30A}. This fault causes the tube to conduct more heavily with a resultant increase in voltage across R_{182} and, in turn, a decrease in the V_{30A} plate voltage and the voltage on the blue grid of the picture tube. A similar reduction in the blue grid voltage would occur if the resistance of R_{182} increased.

After comparing the defects that could occur in Figure 1 and Figure 2, with the same results in the appearance of the raster, it becomes clear that the technician must be familiar with the circuitry of the particular receiver being serviced before he can make an accurate analysis of the cause of the trouble. In both receivers, the best procedure is to adjust the controls that could affect the cathodes, control grids or screen grids of the picture tube; change any tubes that are an integral part of these circuits; and measure the voltages at the various elements of the color picture tube.

OVERALL PICTURE TINTING

Troubles in the color video amplifier circuits usually result in an **overall** tinting of the picture but not the raster. That is, when the contrast control is reduced to its minimum setting, the raster is a neutral shade of gray or a dim white, but when the contrast control is turned up, the picture takes on an overall tint.

Once again, an understanding of colorimetry will be very useful in tracking down and correcting the difficulty. This time, assume that the picture takes on an overall cyan tint as the contrast control is turned up. Cyan is a combination of blue and green, and indicates a lack of red in the reproduced picture. Naturally, the first thing to do is to go through the black-and-white adjustment procedure described fully in a previous lesson as there is always the possibility that the controls have been misadjusted. These include the screen, background, blue and green gain controls. If adjustment of these controls does not correct the difficulty, an investigation of the red video amplifier circuit is necessary.

For this analysis, the color amplifier circuits of the CBS-Columbia Model 205 Color TV receiver, shown in Figure 3, shall be used. Before investigating these circuits, however, it will be well to point out a few facts concerning the video amplifiers in a color TV receiver.

The signal voltages amplified by color video amplifiers, V_{25}, V_{26}, and V_{27}, are in this case, exactly the same type of signal voltage that is amplified in the video circuits of a black-and-white TV receiver. Even though the signal in the green channel is called the green video signal, the signal in the blue channel is called the blue video signal and the signal in the red channel is called the red video signal, ALL OF THESE SIGNALS ARE MERELY VOLTAGES. The various colors are produced by the chemical make-up of the phosphors used to construct the phosphor-dot screen in the picture tube.

For example, if a white vertical bar is to be reproduced by a color TV receiver, it is necessary that the pulse of voltage be amplified by all three color video amplifiers at the same time so that the three guns of the color picture tube can be excited simultaneously. If all three of these pulse voltages are observed on the screen of an oscilloscope, they will be identical in appearance with one slight exception. The amplitude of the signal from the OUTPUT OF THE RED VIDEO AMPLIFIER WILL BE GREATER than the amplitude of the signal outputs from the green and blue video amplifiers. Therefore, the procedures that are used to troubleshoot the video amplifier section of a black-and-white TV receiver are the same as those used to troubleshoot the color video amplifier circuits of a color TV receiver.

Getting back to Figure 3, the next step following the black and white set-up adjustments is to replace all tubes that could affect the red gun signal voltage or the "changing" direct voltage that is a result of the signal voltage. There are only two tubes that could affect these voltages. They are V_{27}, (12BH7) used as the red adder and red output, and V_{28} (6BC7), one-third of which is used as the red d-c restorer.

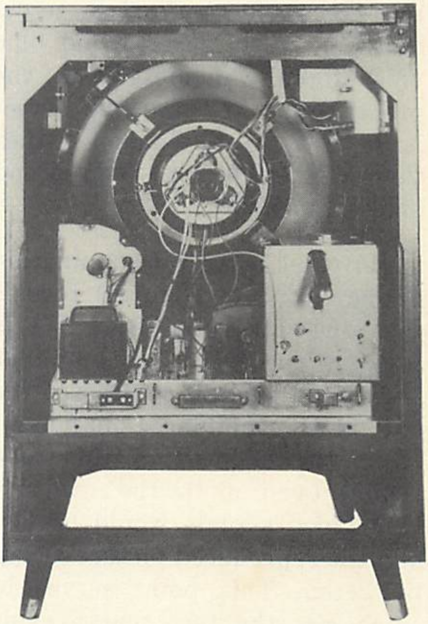
Somewhat like the filament structure of the picture tube, the 6BC7 has a filament for each diode and it is very possible that the filament supplying the red d-c restorer diode could open while the other two filaments remain intact. When a signal is carried by the video amplifier, the voltage developed by the red d-c restorer is normally a positive voltage. Applied to the grid of the picture tube, this voltage counteracts the regular bias voltage and permits the tube to conduct more heavily. When the d-c restorer is not functioning, this positive voltage is not developed, the red gun does not conduct sufficiently and the reproduced picture has a cyan tint.

If replacement of V_{27} and V_{28} does not overcome the fault, it will be necessary to investigate the red adder and red output circuits more thoroughly. In order to simplify this investigation and save valuable time, a thorough analysis of the circuits involved will be helpful.

Starting at the upper left in Figure 3, the luminance or Y signal is applied through $R_{25A\text{-}1}$ to the green adder, through $R_{26A\text{-}1}$ to the blue adder, and through $R_{27A\text{-}1}$ to the red adder. Since the symptom indicates that the blue and green circuits are functioning properly, it is not necessary to investigate any portion of the receiver preceding this Y signal input point. The fact that the blue and green circuits are functioning satisfactorily indicates that the Y signal input must be normal.

An oscilloscope can now be used to trace the video signal through the red channel. To determine if the amplitude of the video signal is correct, set the blue gain control, $P_{26\text{-}1}$, to its maximum clockwise position. The video signal in the blue channel can be used as a "yardstick" for measuring the signal in the red channel. Since the circuits following the adder inputs are identical in all respects, the video signal at various points in the red channel will be exactly the same as the video signal at corresponding points in the blue channel.

When a point in the red channel is located where the signal is lost or considerably reduced in amplitude, the fault will lie in the circuit immediately preceding or immediately following the point at which the signal was not proper. If the proper wave-form is obtained at pin 7 of V_{27A} but none at all at pin 2 of V_{27B}, the difficulty could be caused by any of the components between these two points. Static voltage and resistance measurements will determine exactly which component is at fault.



A rear view of the RCA Model 21CT55 Color TV receiver. The chassis mounted separately at the upper right hand corner of the cabinet contains the convergence circuitry.

Courtesy RCA Service Company, Inc.

Once again, keep in mind that the video signal wave-forms observed on an oscilloscope will be identical to those observed in the video amplifier circuits of a black-and-white TV receiver.

A worthwhile point that should be brought to your attention is the sometimes confusing conditions that occur due to the use of multi-purpose tubes. Referring back to the circuit of Figure 1, assume that the reproduced picture is green. From our previous explanations, we know that this condition is due to an increase in the green video signal or a decrease in both the red and blue video signals. In most cases, the probabilities are that the defect is in the green channel rather than a defect in both the red and blue channels.

However, a careful examination of the circuit of Figure 1 reveals that one-half of a 6BK7 (a) is used as the red video amplifier and the other half is used as the blue video amplifier. Consequently, if the filament of this tube should open, both the red and blue video signals would be lost and the reproduced picture would be green. This point serves to emphasize the fact that a color TV receiver can be serviced more quickly if the technician is familiar with the circuitry of that particular receiver.

HORIZONTAL COLOR BARS

The presence of 60 cycle hum in any one of the three color video amplifiers will appear as two wide horizontal color bars during the reception of a black-and-white telecast. The colors reproduced will be one of the primary colors and its complementary color. To refresh your memory here, a complementary color is one which must be added to the primary color to produce white. Cyan is complementary to red, yellow is complementary to blue and magenta is complementary to green.

In the circuit of Figure 3, if heater-to-cathode leakage develops in tube V_{27}, a red horizontal bar and a cyan horizontal bar will be superimposed upon the screen image. This peculiar condition is due to the fact that when the positive half cycle of the 60 cycle hum voltage is applied to the red grid of the color picture tube, its conduction increases and the picture takes on a reddish tint. Then, when the negative half cycle occurs, the conduction of the red gun decreases and the tint is determined by the green and blue guns which results in a cyan bar.

The actual location of the red and cyan bars on the picture tube screen is determined by the phase of the hum voltage with respect to the vertical sweep voltage. If the positive half cycle of the hum voltage occurs at the beginning of the vertical sweep voltage, the top of the picture becomes red and the bottom cyan. If the positive half cycle of the hum voltage occurs at the end of the vertical sweep voltage, the bottom of the picture becomes red and the top cyan.

If the horizontal bars are blue and yellow, the hum voltage is being introduced in the blue video circuits. If the horizontal bars are green and magenta, the hum voltage is being introduced in the green video circuits.

Usually, the I and Q circuits do not affect the signals applied to the grids of the color picture tube during monochrome reception. An exception to the rule is when a hum voltage is introduced into the I or Q demodulators or their associated amplifiers. Although the I and Q circuits are not shown in Figure 3, the diagram indicates the points at which the I and Q signals are fed into the adder input circuits. Therefore, any hum voltages that are present in the I and Q circuits will be superimposed upon the black-and-white video signals.

If the 60 cycle hum voltage occurs in the I circuits, the two horizontal bars become orange and cyan. If the 60 cycle injection occurs in the Q circuits, the bars become magenta and yellowish-green. When the amplitude of this leakage voltage is small, the horizontal bars are pale in color and it may be difficult to determine where the hum voltage originates, as this voltage in the red video amplifier produces almost the same effects as a hum voltage in the I circuits. In this case the service procedure is—remove the last tube in the I circuits and notice the effect on the picture. If the hum bars remain, the trouble lies in the red video amplifier circuits; if the hum bars disappear, the trouble lies in the I circuits.

The same troubles are encountered when a hum voltage gets into the green video circuits or the Q circuits as the bars are very similar in color. For a check, remove the last tube in the Q circuits and observe the effect. If the hum bars remain, the trouble is in the green video circuitry; if the hum bars disappear, the trouble is in the Q circuits.

NO MONOCHROME PICTURE

As in a black-and-white TV receiver, troubles may occur in a color TV receiver that cause a complete loss of the monochrome picture. To analyze this particular possibility, the CBS-Columbia Model 205 TV Receiver has been chosen. The complete schematic diagram of the receiver is indicated as Figure 4. From this diagram, you may get the impression that locating a fault of this type is going to be very difficult. On the contrary, however, as the following explanations indicate, it will become clear that the particular stages in which the trouble can occur are relatively few.

First of all, in order to produce a raster, the portion of the receiver, labelled CBS COLORTRON

SECTION, which directly affects the conduction of the picture tube must function properly. Also, in order to produce a raster, the low voltage power supply, the vertical deflection system, and the horizontal and high voltage sections must operate normally. When functioning correctly, all of these circuits can be eliminated as the possible cause of no monochrome picture.

The 6CU6 shown above is used as a horizontal deflection amplifier in some of the present color TV receivers.

Courtesy CBS-Hytron

Since convergence circuits aid in the reproduction of a monochrome picture free of any color fringes and does not have any bearing on the absence or presence of the monochrome signal, the CONVERGENCE SECTION can be eliminated as a possible source of this particular trouble.

In the MATRIX & ADDER SECTION, a defect in any one of the color video amplifiers causes a tinting of the monochrome picture. In order for this section to cause a complete loss of the monochrome picture, a defect has to occur in each of the three amplifier circuits or in a component which is common to all three circuits. The only component that could prevent all of these circuits from operating is the adder common cathode resistors $R_{27A\text{-}5}$ and $R_{27A\text{-}6}$. After verifying the proper values of these resistors, the matrix and adder circuits can be eliminated as a possible cause of the assumed trouble.

The next circuits to consider are the COLOR SYNC-AFC SECTION and the Q and I DEMODULATION SECTION. Since these circuits function only during a color reception and have no function whatsoever during a monochrome reception, they can be eliminated.

Up to this point, the only sections of the receiver that have not been eliminated are the VIDEO AMPLIFIER SECTION, the SOUND

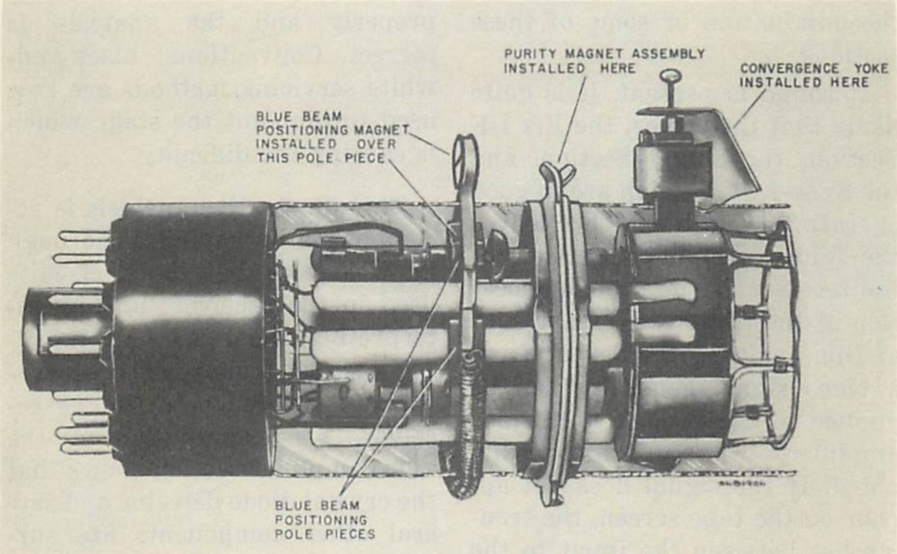
SECTION, the PIX (PICTURE) SECTION, the SYNC-AGC SECTION and the TUNER. These are exactly the same sections in a black-and-white TV receiver that could cause a complete loss of the video signal and a few tests, some already described for B-W (black-and-white) television, leads to the elimination of some of these sections.

If sound is present, it is quite likely that the Tuner, the Pix I-F Section, the Sound Section, and the Sync-AGC Section are in good operating condition. This leaves the Video Amplifier Section of the receiver as the probable location of the trouble. To make sure of this analysis, the output from a video signal generator can be applied to the grid of first video amplifier V_{14} and the results noted. If the signal does not appear on the tube screen, the trouble lies between the input to the first video amplifier and the output of second video amplifier V_{15A}. If the signal appears on the screen when the generator output is applied to the grid of the first video amplifier, the trouble lies between this point and the output of the 5th Pix I-F Amplifier. Since this circuitry includes the 1N60 crystal diode used as the video second detector, this component should be checked or changed.

If both picture and sound are missing, the trouble probably lies in the Tuner or the Pix I-F section with a possibility of the Sync-AGC Section being at fault. This line of reasoning can be verified by applying a video signal to the grid of the first video amplifier and noticing the results. If a picture appears, the video amplifier section must be functioning properly and the analysis is correct. Conventional black-and-white servicing methods are now used to pinpoint the stage which is causing the difficulty.

This illustrative analysis is accomplished by having a thorough knowledge of the type of circuits used in the receiver; and by interpreting the results of injecting a signal from a video generator at a desired point in the receiver. An examination of the video amplifier section shows that the crystal diode detector and several other components are surrounded by a dotted line. This dotted line indicates that all of these components are enclosed in a can that is similar in appearance to the i-f transformer cans in an ordinary radio. Usually, the top of this can is removable to provide easy access to the 1N60 crystal diode. Therefore, the top of the can is removed and the hot lead from the signal generator is clipped to the output of the crystal detector while the ground lead is connected to the nearest convenient ground point.

If the receiver is constructed so that this "connection" cannot be made, remove the first video amplifier from its socket and wrap a piece of fine wire around the grid pin being careful to avoid contact with any other pin. One end of the wire can be brought out as a test point for the generator hot lead and the tube reinserted into its socket. The complete procedure is very simple, requiring only a few minutes and enables the technician to quickly isolate the faulty section of the receiver.


PURITY MAGNET ASSEMBLY INSTALLED HERE
CONVERGENCE YOKE INSTALLED HERE
BLUE BEAM POSITIONING MAGNET INSTALLED OVER THIS POLE PIECE
BLUE BEAM POSITIONING POLE PIECES

This photograph of an electron gun assembly shows the exact positions of the blue beam positioning magnet, the purity magnet and the convergence yoke on the neck of the 21AXP22 magnetic convergence type color picture tube.

Courtesy RCA Service Company, Inc.

After the isolation process has been completed, the tubes in the suspected sections are checked or replaced to be certain that they are in good condition. If replacement of the tubes does not correct the difficulty, a more thorough investigation of the suspected circuits will have to be made, following procedures already described for B-W TV receivers.

Many technicians prefer to carry a minimum of parts and equipment when making service calls and do not include a signal generator. In this case, it is necessary to change the tubes that could cause the particular trouble. These include the video amplifiers, the video i-f amplifiers, the tuner tubes, agc tubes and the video detector.

IMPROPER COLOR PURITY

Improper color purity occurs when the electron beam from any one of the three guns is not striking the correct set of phosphor dots. The effects on a monochrome picture appear as uneven color areas at various points on the screen of the color picture tube. In severe cases, the entire picture is off-center and neck shadow may be seen near the edge of the screen.

To determine definitely if the trouble is due to a defective component in the purity circuits, the contrast control is set to its fully counterclockwise position so that only a raster is visible on the CRT screen. Purity troubles cause the raster to contain uneven color areas on the screen instead of presenting a dim white raster. A further check can be made by reducing the screen voltage to the blue and green guns and observing only a red raster.

Edge Contamination

If impurities occur at the edges of the raster, the field neutralizing control should be adjusted while the raster is being observed. Either an open or a shorted turn in the field neutralizing coil reduces the magnetic field produced by the coil so that little or no effect on the raster is noticed as the field neutralizing control is adjusted. The remaining possibility is that the control itself is defective and causes a constant current in the coil regardless of the control setting.

To obtain a better understanding of how these conditions can occur, examine the circuitry of the field neutralizing coil and its control in the upper right portion of the low voltage power supply section of Figure 4. (This section is located in the lower left portion of the complete diagram.) As shown, the field neutralizing coil is connected in parallel with the movable arm and the fixed center tap of the control. This arrangement permits the current through the coil to be varied in both amplitude and direction. If the coil opens, all of the B+ current passes through the control; if the control opens, all of the B+ current passes through the coil. In either case, adjustment of the control has no effect upon the raster.

Generally, the field neutralizing coil is connected to the power supply by means of a plug-in connector. Assuming this to be the case, the coil can be unplugged (with the receiver turned off) and an ohmmeter used to make a continuity check of the coil and the control. If both components show continuity, the probabilities are that the coil has a shorted turn and it should be replaced. Before replacing it, however, carefully examine the points at which the leads connect to the coil and to the plug-in connector as both shorts and breaks commonly occur at these points.

In many cases, the owner of the color TV receiver may not want the receiver to be taken off the premises if it can be repaired on the spot. Should the improper color purity be due to a defective coil, impurities at the edges of the screen may be corrected by holding small permanent magnets around the outside of the front of the picture tube next to the areas where the contamination occurs. The magnets can then be turned and positioned to "pure up" the contaminated areas, after which they can be taped into position.

If the trouble is due to an open in the field neutralizing control, it can also be repaired without too much difficulty. This is done by soldering a length of hook-up wire from the fixed tap of the control to one end of the control to short out the open section. This procedure allows current through the neutralizing coil in one direction only and the control has no effect when it is being varied over the control portion that is shorted out. Under these conditions, there is a fifty percent chance that the current through the coil is in the wrong direction and the contamination cannot be cleared up. This latter condition can be remedied by removing the plug-in connector and reversing it. If the connector is made so that it can be inserted one way only, it is necessary to break the coil leads to the connector and reverse them. When this is done, the current through the field neutralizing coil is reversed and proper adjustment to eliminate the edge impurities can be made.

Some receivers employ a number of small permanent magnets (usually 8) around the outside of the front of the picture tube to correct for edge impurities. Therefore, the magnet which is closest to the affected area should be adjusted to obtain purity, if possible. Should adjustment of the magnet have little or no effect upon the impure area in its vicinity, the probabilities are that the magnet is defective and must be replaced.

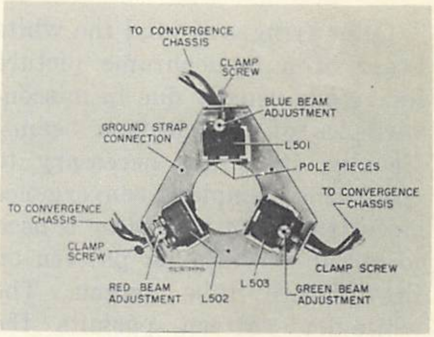
Center Contamination

Contamination of the raster at or near the center of the screen is due to a misadjustment of, or a defect in the purity coil or the purity control. Referring once again to the low voltage power supply section of Figure 4, the purity coil is shown connected in parallel with the movable contact and one end of the purity control. This arrangement permits the purity coil current to be varied in amplitude but not direction.

Like the field neutralizing coil, the purity coil usually is connected to the power supply circuits by a plug-in connector which can be removed to permit the resistance of the coil and the control to be measured individually. Although not indicated on the diagram, the purity coil is actually two windings connected in parallel. The resistance of each of these windings is approximately 40 ohms so that the resistance of the paralleled windings is about 20 ohms. Therefore, it is possible for only one of these windings to open (or short) and cause some misleading symptoms.

Ordinarily, when the purity coil opens, adjusting its control has no affect upon the raster. With two windings connected in parallel, adjustment of the purity control affects the raster even though one of the windings is defective. The best policy then, is to check the resistance of the purity control. If the purity control is in good condition, the purity coil should be replaced.

Many of the later model color TV receivers use permanent magnet(s) as the purity device rather than a coil. Since it is quite difficult to definitely ascertain the condition of this purity magnet, replacement of the magnet is the best policy. The magnet can be removed in a few minutes by pulling the socket from the base of the color picture tube, sliding the blue lateral corrector magnet off the neck of the picture tube and doing the same with the purity magnet. After installing a new purity magnet, placing the blue lateral corrector magnet in its original position and connecting the tube socket to the base of the CRT, the necessary adjustments can be made to obtain purity and convergence.



The various components that make up the convergence yoke assembly along with the beam positioning adjustment screws are illustrated here.

Courtesy RCA Service Company, Inc.

Generally, it is not necessary to go through the complete convergence adjustments (assuming that the convergence was correct before the replacement of the purity magnet) and a simple procedure can be followed to save time.

In short, obtain a white-dot pattern on the picture tube screen from an appropriate generator and adjust the blue lateral corrector magnet for best center convergence. Go through the complete purity adjustment procedure as described in the previous lesson but do not move any of the convergence control settings. Finally, readjust the blue lateral-corrector magnet for best center convergence and the remainder of the dot pattern will also be properly converged.

COLOR FRINGING

Color fringes around the white areas of a monochrome picture image are usually due to misconvergence of the electron beams. Usually, it is not necessary to check the complete convergence circuits if a dot generator is used to obtain a white-dot pattern on the picture tube screen. The white-dot pattern permits the technician to determine whether the trouble is in the static convergence adjustments (or circuits), or in the dynamic convergence adjustments (or circuits).

Electrostatic Convergence Tubes

To be more specific, troubles in the convergence circuits of the RCA Model CT-100 can be analyzed by referring to Figure 5. In this receiver, the color picture tube is the electrostatic convergence type and employs a convergence electrode. Accordingly, it is necessary to apply "d-c" and dynamic voltages to the convergence electrode.

With a dot generator connected to the input of the receiver, the dot pattern on the picture tube screen can be observed while the d-c convergence control and the beam positioning magnets are adjusted for best center convergence. If proper center convergence cannot be obtained, the d-c convergence voltage should be checked with a vtvm and a high voltage probe to make certain that it is variable between 9,000 and 11,000 volts. The high voltage circuits (not shown in the diagram) can be investigated if the direct voltage range is not correct.

Improper center convergence can be caused also by a defective beam positioning magnet. This can usually be determined by observing the dot pattern while varying the position of the magnets. Each magnet should cause its respective color dot to move at right angles to the direction of motion of the magnet. If it is suspected that one of the magnets is defective, it should be replaced.

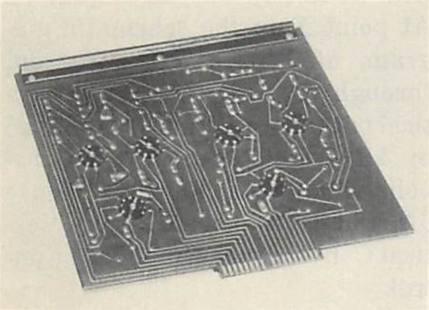
The majority of convergence troubles occurs in the dynamic convergence circuits and therefore the technician must understand how these circuits function, in order to save time and effort in locating the faults. The first thing to do is to examine the reproduced dot pattern on the screen of the picture tube to see if the trouble is common to both the horizontal and vertical convergence circuits or is confined to one. If the vertical line of dots through the center of the screen is good, the vertical circuits are functioning properly. If the horizontal line of dots through the center of the screen is properly converged, the horizontal circuits are in good condition.

For the moment, assume that the center vertical row of dots is not converged at the top and bottom, and neither the vertical amplitude nor the vertical shape control permits proper adjustments to be made. Also, assume that replacement of the vertical convergence amplifier tube does not correct the misconvergence. It is possible for the trouble to be located by making voltage and resistance measurements and checking the quality of various components in the circuit. However, a better and faster way to locate the difficulty is to measure the wave-forms at various points in the convergence stages.

As explained in a previous lesson, the electron beam converges too soon as it is deflected away from the center of the screen, unless a voltage is applied that causes the convergence electrode to gradually become more positive as the electron beam is deflected. Therefore, a parabolic voltage, having the shape of Figure 6B, is employed to accomplish the desired results. Since this dynamic convergence voltage must be the same frequency as the scanning rate, it is obtained from the vertical deflection output amplifiers. At point X in the schematic diagram, of Figure 5 the current through the primary of the vertical output transformer is shaped by $1R_{277}$ and $1C_{146B}$ into a parabolic voltage, as shown in Figure 6A, and developed across the Vertical Convergence Amplitude Control.

In order to compensate for any irregularities in the parabolic wave-form, a sawtooth voltage of either polarity is added to the parabola at the grid (pin 7) of the vertical convergence amplifier. Capacitor $1C_{242}$ is the sawtooth forming capacitor for the vertical oscillator (not shown) and a positive going sawtooth is taken from it and fed to one end (lower) of the Vertical Amplitude Shape Control. A positive pulse at the plate of the vertical output tube is shaped by resistor $1R_{252}$ and capacitor $1C_{209}$ into a negative going sawtooth and applied through resistor $1R_{251}$ to the other end of the Shape Control. Therefore, the wave-form at the movable contact of the shape control is a sawtooth that changes in amplitude and polarity as the control is adjusted.

At pin 7 of the vertical convergence amplifier tube, a symmetrical parabolic voltage should be obtained. This voltage is amplified and appears at pin 6 as the wave-form of Figure 6B. This same voltage is further amplified by the vertical convergence output stage and appears at pin 1 as shown in Figure 6A. Naturally, as the signal progresses through the amplifiers, its amplitude is increased proportionately. Loss of the wave-form at any point indicates that the defect lies at that point or circuits related to it.



Printed circuit boards similar to the one pictured above are becoming increasingly popular in color TV receivers. They require more careful servicing techniques by the technician, especially in the use of a soldering iron.

Courtesy Photocircuits Corp.

If all of the wave-forms are proper up to and including the plate circuit of the output amplifier (pin 1), the probabilities are that the misconvergence fault is in the vertical convergence transformer, resistor $3R_{239}$ or capacitor $3C_{204}$. Unfortunately, the direct voltage in the secondary circuit of the convergence transformer is about 3000 volts and the oscilloscope cannot be used to measure the wave-form at this point unless a special probe or high voltage capacitor is used in conjunction with the scope. However, the receiver can be turned off, the transformer checked for continuity, the resistor checked for proper resistance and the capacitor $3C_{204}$ replaced if necessary.

Going back to the dot-pattern observed on the screen of the picture tube, if the dots are converged properly in the center vertical row but are not converged properly in the center horizontal row, the horizontal convergence circuits should be investigated.

Referring once again to the schematic diagram of Figure 5, a negative polarity pulse at "E" is obtained from a winding on the horizontal output transformer and has the appearance of Figure 7A. The pulse is coupled through capacitor $1C_{306}$ and the Horizontal Convergence Amplitude Control to be developed across the Horizontal Convergence Phase Coil $1L_{138}$. This coil, in conjunction with its distributed capacitance and $1C_{306}$, forms a resonant circuit that is shock excited by the pulse to produce the voltage wave-form indicated in Figure 7B. If the proper wave-form is not obtained at the ungrounded terminal of the phase coil, the trouble lies ahead of this point or in the coil.

However, if the proper waveform is obtained, the trouble lies after this point. The only components that could cause the misconvergence in this case, are the capacitors $3C_{202}$, $3C_{203}$, $3C_{205}$ and the coil $3L_{139}$. It is not likely that capacitor $3C_{204}$ would be defective as it would also affect the vertical convergence.

There is a possibility that none of the convergence controls have any effect at all on the dot pattern. This condition indicates that a component common to both circuits is at fault. An examination of the circuit reveals that only a few components can cause this difficulty. They are capacitors $3C_{203}$, $3C_{204}$ and $3C_{205}$. When making tests, if these capacitors prove to be good and all wave-forms are good, check the wiring to the convergence electrode pin on the picture tube socket and check the socket itself. Finally, there is always the possibility that the color picture tube is defective.

It should be remembered that the foregoing explanations, relating to the assumptions made, are only for the particular circuit illustrated. However, the majority of the color TV receivers that use the electrostatic convergence type picture tube incorporate circuits that are similar to the one described because the dynamic convergence voltages must be approximately as shown regardless of the circuit design.

Magnetic Convergence Tubes

The convergence circuits in the magnetic convergence color picture tube are considerably more complex than the circuits used with the electrostatic convergence picture tube. Because of this complexity, it is necessary for the service technician to analyze the white-dot pattern on the picture tube screen very thoroughly in an effort to ascertain what portion of the convergence circuits are at fault. It is equally important for the technician to be familiar with the circuits used in the receiver being serviced.

Figure 8 is the schematic diagram of the convergence circuits used in a 19″ Motorola color TV receiver and it shall be assumed that the receiver being serviced employs these circuits. Furthermore, since there are three groups of similar circuits, assume that the group at the left in the diagram are for the red gun, the middle components for the green gun and the right hand components for the blue gun.

Examination of a white dot pattern on the color tube screen reveals that the red and green dots are properly converged at all points but the blue dots are not converged on a vertical line through the center of the screen. Adjustment of the blue vertical tilt control and the blue vertical amplitude control will now help to isolate the trouble still further. If the blue vertical amplitude control causes the blue dots to change position but the tilt control does not, the trouble is undoubtedly in the vertical tilt circuit.

It is quite unlikely that the tilt control itself would be defective as the plate current of the vertical deflection output amplifier must pass through all three of the vertical tilt controls and L_4 in order to return to B+. Therefore, an open in any of these components would disable the vertical output stage and the raster would reduce to a horizontal line. This leaves C_3 and the blue vertical tilt coil as the most likely sources of trouble. In the event that the coil is defective, the entire L_7 assembly must be replaced.

If the blue vertical tilt control causes the blue dots, along the center vertical line of the CRT screen, to change position but the blue amplitude control does not, then the trouble is more than likely in the control itself or in C_6. Let's see why this conclusion has been reached. Capacitor C_7 couples the parabolic voltage to all three of the convergence coils and a defect in it would affect all of the dots on the picture tube screen. The blue convergence coil carries the horizontal converging current as well as the vertical and a defect in it would affect the blue dots at all points on the CRT screen. The same reasoning applies to L_3 which leaves only C_6 and R_6 as possible sources of trouble.

If it is found that neither the blue vertical amplitude control nor the tilt control have any effect, the chances are that the L_7 assembly is defective as it is the only component that is common to both circuits.

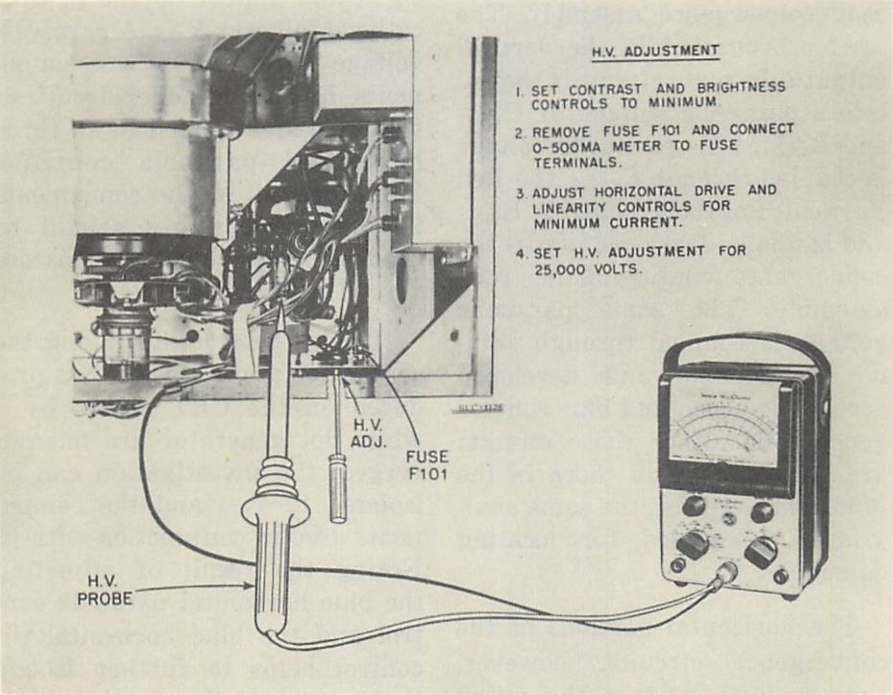
Now, assume that the dot pattern is not converged along the center horizontal line due to the blue dots being out of place and that neither the blue amplitude control nor the blue phase control have any effect toward converging the blue dots. This could be caused by an open in C_{11}, C_6, R_9 or a short in L_3. Obtained from a winding (T4) on the horizontal output transformer, a positive horizontal pulse is developed across R_9 which is coupled through C_{11} to shock excite L_3. Therefore if any of these components become defective, neither of the horizontal controls have any effect.

As to defects that cause misconvergence of either the red dots or the green dots, the same analysis can be applied to the corresponding circuit components because the three (circuits) are identical.

If it should happen that all three groups of dots are misconverged in the vertical direction, the chances are that either L_4 or C_8 is shorted or C_7 is open as these components cause the parabolic voltage to be applied to all three convergence coils.

About the only things that could cause all of the dots to be misconverged in the horizontal direction is an open in T_4 or a short from one of the horizontal convergence amplitude controls to its grounded case.

The lower right hand portion of Figure 4 shows the convergence circuits for the Columbia Model 205 Color TV Receiver. The vertical portions of this convergence section are very similar to the vertical circuits of the Motorola receiver previously analyzed. The fixed tap on the Red Vertical Tilt control actually is connected to one end of the primary of the vertical output transformer. This means that the plate current of the vertical output tube must pass through portions



H.V. ADJUSTMENT

1. SET CONTRAST AND BRIGHTNESS CONTROLS TO MINIMUM.
2. REMOVE FUSE F101 AND CONNECT 0-500MA METER TO FUSE TERMINALS.
3. ADJUST HORIZONTAL DRIVE AND LINEARITY CONTROLS FOR MINIMUM CURRENT.
4. SET H.V. ADJUSTMENT FOR 25,000 VOLTS.

Extreme care must be exercised by the technician when checking or adjusting the high voltage in a color TV receiver. A high voltage probe is a required piece of test equipment.

Courtesy RCA Service Company, Inc.

of the Red Vertical Tilt Control, the Green Vertical Tilt Control and the Blue Vertical Tilt Control, and through R_{43A-4} before finally returning to B+.

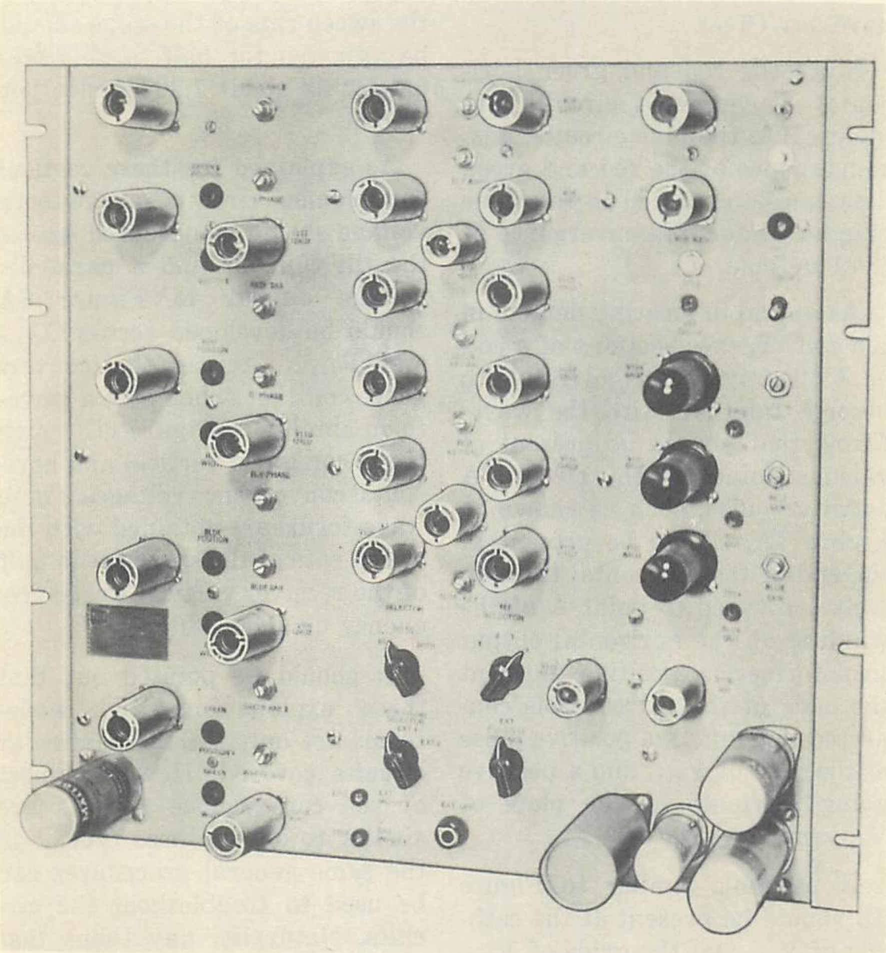
A sawtooth of voltage is developed across each tilt control and applied to the tilt windings of each convergence assembly. The sawtooth current in the vertical output tube plate circuit is shaped into a parabolic voltage by C_{43A-5} and R_{43A-4}. This parabolic voltage is coupled through C_{43A-6}, the Red Vertical Parabola control, L_{43A-1} and is finally developed across the convergence winding of the "red" assembly. The same parabolic voltage is coupled through similar components and developed across the green and blue convergence coils. Since these circuits are very similar to those in the Motorola Receiver, the same analysis can be used for locating defects.

The horizontal portions of the convergence circuits, however, are very different from those used in the Motorola receiver and warrant further explanation. If the dot pattern observed on the screen of the color picture tube shows that all of the dots along the center horizontal line are misconverged, the difficulty could be caused by any of the components in the V_{41A} or V_{42A} circuits as these two stages develop the parabolic voltage for all three convergence coils.

A positive pulse is taken from tap D on the horizontal output transformer and applied to the grid of the discharge tube V_{41A}. In the output of this stage, a sawtooth voltage is developed across C_{41A-2} and applied to the grid of cathode follower V_{42A}. A parabolic voltage is formed by the components in the cathode circuit of this tube and applied to all three horizontal parabola controls. Therefore, all of the components in these two stages should be checked if the dots are misconverged horizontally.

If only the blue dots along the center horizontal line of dots produced on the CRT screen by a white dot generator are misconverged, the investigation can be isolated to V_{41B} and the components used in conjunction with it. Noting the result of adjusting the blue horizontal parabola control and the blue horizontal tilt control helps to further isolate the trouble. If the parabola control has no effect on the blue dots but the tilt control does, the possible defective components are the parabola control itself, C_{42A-4}, R_{42A-8}, or an open in the D portion of the winding on the horizontal output transformer.

If the opposite results are obtained, the defective component is the blue horizontal tilt control,



This is a top chassis view of a color bar generator capable of producing a variety of patterns which enable the technician to service and adjust color TV receivers in a minimum of time.

Courtesy Telechrome Manufacturing Corp.

R_{41B-7} or the A winding of the horizontal output transformer. If neither the blue parabola nor tilt controls have any effect, the defect probably lies in V_{41B} or its associated components. However, this misconvergence could be caused by a defect in the winding on the horizontal output transformer that supplies the pulses to the convergence circuits. In this case, it is more than likely that all of the dots would be misconverged and none of the horizontal convergence controls would have any effect.

Since the red and green horizontal convergence circuits are identical to the blue circuits, misconvergence of the red and green dots can be analyzed in the same manner as for misconvergence of the blue dots.

As an aid in locating defects in the convergence sections of a color TV receiver, it is advisable to become familiar with the wave-forms that should be present at various points in the circuit. A negative pulse, such as shown in Figure 7A, should be present at the end of the horizontal tilt controls connected to point A of the winding on the horizontal output transformer, a positive pulse at the ends of the tilt controls connected to point D, a positive pulse at the grid of V_{41A}, and a positive going sawtooth at the plate of V_{41A} and the grid of V_{42A}.

A parabola similar to Figure 6B should be present at the cathode of V_{42A} and the grids of V_{41B}, V_{42B}, and V_{43A}. Negative or positive pulses can be superimposed upon the parabolic wave-forms at the last mentioned points depending upon the setting of the horizontal tilt controls. Finally, a parabolic voltage similar in shape to Figure 6A should be present in the plate circuits of the three convergence output tubes. All of these wave-forms are at the horizontal scanning frequency, and the sweep rate of the scope should be adjusted for half of this frequency or about 7,867 cycles per second.

As explained for these vertical convergence circuits, a sawtooth voltage should be observed across the tilt controls and a parabolic voltage similar to Figure 6A should be developed across $C_{43A\text{-}5}$ and $R_{43A\text{-}4}$. Across the convergence coil there should be a waveform similar to Figure 6C which is the combined vertical and horizontal convergence voltages. These wave-forms are obtained with the sweep rate of the scope set to half of the receiver vertical sweep frequency or about 30 cps.

It should be pointed out that these explanations and wave-forms are only for the particular circuits covered. However, most of the convergence circuits are similar to one of these types and the same general procedures can be used to troubleshoot the circuits. Naturally, any tubes that could possibly cause a condition of misconvergence should be replaced or checked and the controls should be adjusted before the chassis is removed from the cabinet for a more thorough investigation.

In this lesson, the major causes of troubles that affect the monochrome picture reproduced on the color picture tube have been explained. Naturally, defects other than those mentioned might possibly occur. However, these other defects usually can be isolated to a particular stage in the same manner as described for the defects explained in this lesson and, once located, logical static tests can be used to find the faulty part(s).

The following lesson explains general servicing procedure for troubles affecting the reproduction of a color picture.

STUDENT NOTES

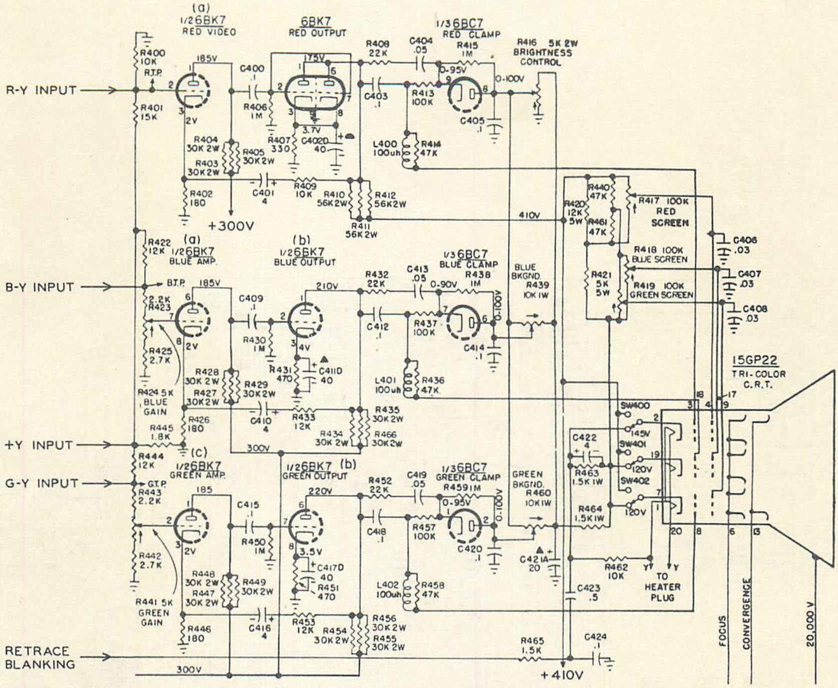


FIGURE 1

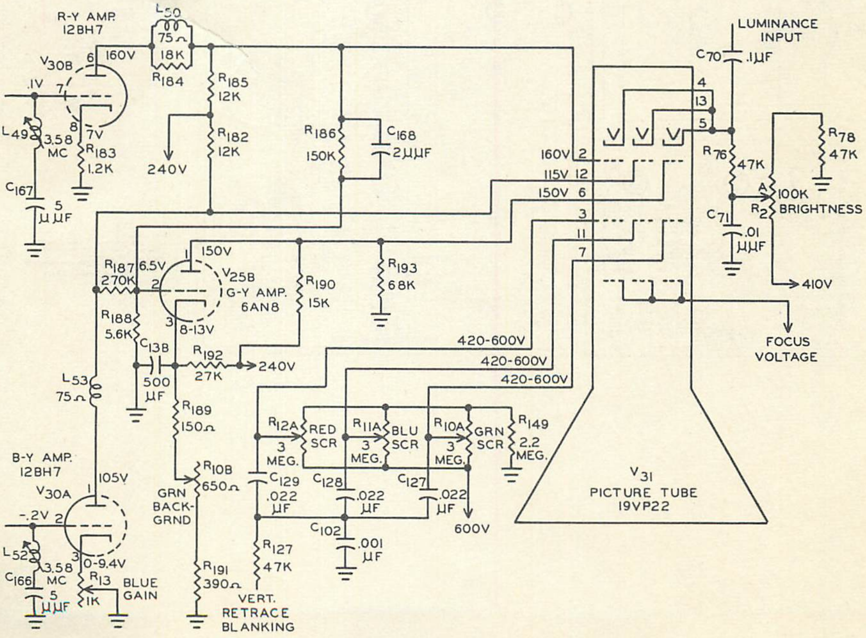


FIGURE 2

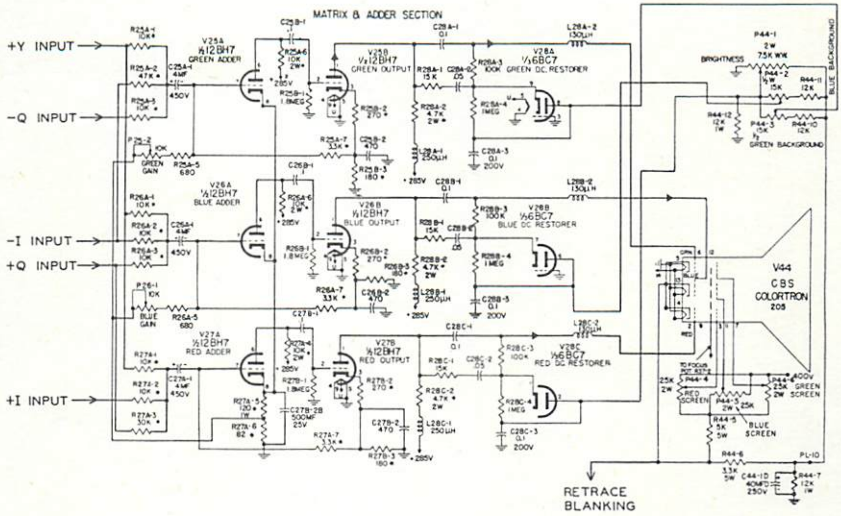


FIGURE 3

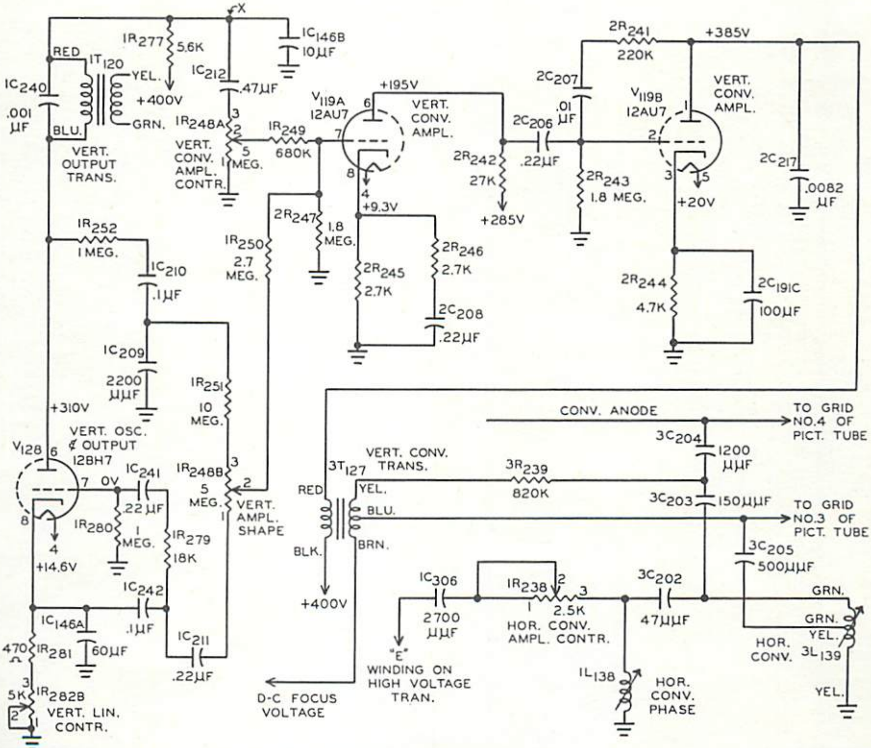
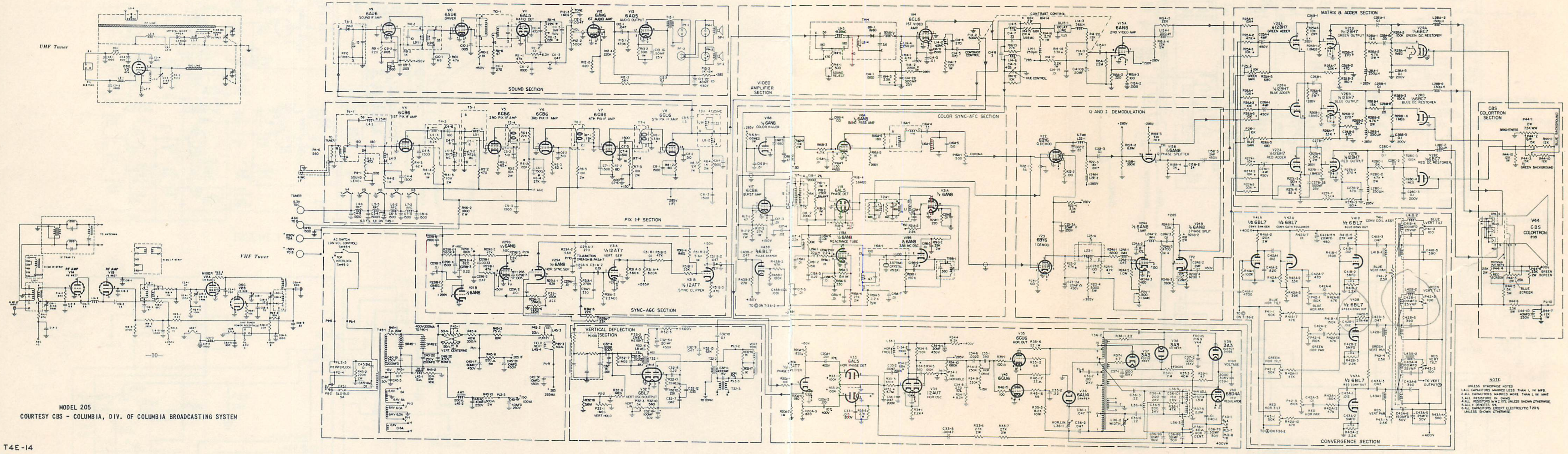


FIGURE 5



NOTE:

UNLESS OTHERWISE NOTED
1. ALL CAPACITORS MARKED LESS THAN 1, IN MFD.
2. ALL CAPACITORS MARKED MORE THAN 1, IN MMF.
3. ALL RESISTORS IN OHMS
4. ALL RESISTORS ½ W ± 10% UNLESS SHOWN OTHERWISE.
5. ALL * DENOTES 5%
6. ALL CAPACITORS EXCEPT ELECTROLYTIC ± 20% UNLESS SHOWN OTHERWISE

MODEL 205
COURTESY CBS - COLUMBIA, DIV. OF COLUMBIA BROADCASTING SYSTEM

T4E-14

FIGURE 4

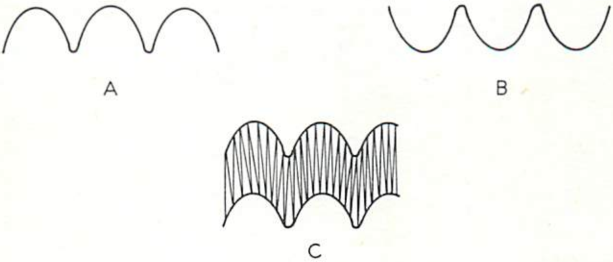


FIGURE 6

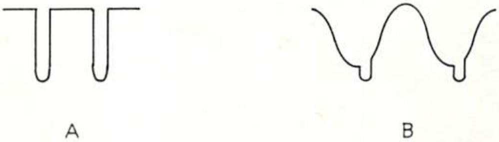


FIGURE 7

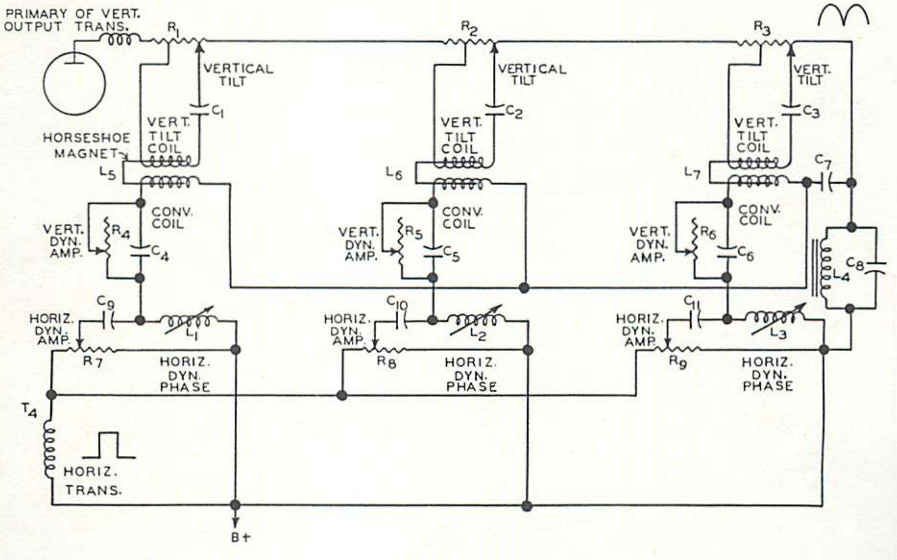


FIGURE 8

FROM OUR *Director's* NOTEBOOK

YOUR WORD AS A BUSINESSMAN

When you give your word, or make a bargain or set a policy as a businessman, remember that the success of your business, as well as your own personal reputation, depends upon your following through.

For, example, take the matter of shop hours. If you establish hours from 9:30 a.m. to 5:00 p.m., it is up to you to be available during those hours. Or, you must make arrangements to have someone on hand to carry on for you. Then, if a customer drops in without advance notice, his needs can be satisfied.

If you say you'll be at Mrs. Jones' home between 2:00 and 3:00 p.m., move heaven and earth to be there at that time. If you find you can't make it, call the customer, explain that you are detained, and set a new appointment. And keeping your word in financial matters goes without saying because your credit rating is at stake.

Yes—above all, try to do the things you say you will, for in doing so you are taking an all-important step toward making your business career long and profitable.

Yours for success,

W. C. DeVry

DIRECTOR

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